Title:
Influence of depth dependence of the Earth's mantle properties on thermal-convection characteristics

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Abstract:

This thesis concerns the study of convection in Cartesian models in two and three dimensions. Specifically, it deals with the systematic monitoring of critical Rayleigh numbers based on the geometry model, on the functional dependence of the viscosity or of other parameters.
Models has been created with layered viscosity and constant or temperature- and depth- dependent parameters (thermal expansion and conductivity).
The system has been described by conventional dimensionless Boussinesq approximation.
Part of the work is devoted to the application of matrix method for solving the appropriate Stokes flow and use of Euler's method for solving the thermal equation.
The actual calculations were then performed in an environment of commercial software Comsol and thus by using the finite element method.
It was shown that the dominant influence on the critical Rayleigh numbers has a viscosity model (with increasing viscosity the critical Rayleigh numbers increase), other important parameter is system's geometry (larger size and dimension of the geometry reduce the critical Rayleigh number).
The presence of functional dependencies of thermal expansion and conductivity led to further reduction of the critical Rayleigh numbers. The stratification and layering of the system as well as the development of higher temperature gradient on the borders of these layers was shown on the model approximating Earth
through its model parameters of viscosity, thermal expansion, and thermal conductivity. Next, a nature of the noise generated by time-development of Nusselt number for chaotic regime was determined and confirmed by experiment.